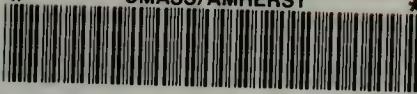


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MASSACHUSETTS COASTAL COMMERCIAL  
LOBSTER TRAP SAMPLING PROGRAM

MAY-NOVEMBER, 1987

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*and*

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COMMONWEALTH OF MASSACHUSETTS  
Division of Marine Fisheries  
Department of Fisheries, Wildlife and  
Environmental Law Enforcement  
Executive Office of Environmental Affairs  
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## ABSTRACT

The seventh consecutive American lobster (Homarus americanus) catch/effort and biological monitoring program was completed in Massachusetts coastal waters in 1987. During the period, May to November 1987, 89 sampling trips were made aboard commercial lobster vessels in Massachusetts coastal waters. A total of 39,022 lobster were sampled from 14,742 trap hauls.

The 1987 coastwide mean catch rate, 0.737 legal sized lobster per trap, was 10% lower than the 1986 index of 0.816. Fishing pressure remained excessive as indicated by the fact that 94% of the legal catch in our inshore regions (Cape Ann south through Cape Cod Bay and Buzzards Bay) was comprised of new recruits, i.e. lobster which recently molted into legal size. In contrast, only 54% of the primarily offshore migrant lobster east of Cape Cod were new recruits.

Estimates of total annual mortality, analyzed by 2 methods, were high, ranging from 84%-93% for inshore Gulf of Maine regions, 91%-97% for Buzzards Bay and 48%-55% for the relatively less exploited outer Cape Cod region.

The mean carapace length of marketable lobster, 89.5mm; percentage of females bearing eggs, 9.2%; sex ratio, 1.5 females/male; and incidence of lobster found dead in traps, <1% were consistent with 1986 data. However, the percentage of culls declined from 20.9% in 1986 to 17.1% in 1987. Trends in the seven year time series of all parameters are presented.



## INTRODUCTION

This is the Massachusetts Division of Marine Fisheries (DMF) seventh annual assessment of the status of the American lobster resource in Massachusetts coastal waters. It was accomplished with data collected through a structured, comprehensive commercial lobster sea sampling effort.

The commercial lobster fishery is the most economically important single-species fishery in Massachusetts coastal waters. Consequently, a long-term coastwide lobster monitoring program yielding biological and catch per unit effort data was devised and initiated in Massachusetts in May, 1981. A sea sampling-survey design was chosen by which both catch per unit effort and biological data could be collected temporally and areally with sufficient precision for stock assessments. The objective was to assess variations in population parameters due to environmental factors, fishing pressure, or the effects of regulatory changes.

Data collected during the 1987 coastwide commercial lobster trap sampling program are summarized below. Parameter trends occurring during the 1981-1987 study period are discussed.

## STUDY AREA

The study area is primarily defined by the Massachusetts territorial sea, except where lobstering activities of cooperating commercial lobstermen exceeded territorial boundaries (Figure 1). Territorial waters total 5,322 sq km (2,055 sq mi), of which an estimated 60% is considered major lobster habitat. Six sampling regions, Cape Ann, Beverly-Salem, Boston Harbor, Cape Cod Bay, outer Cape Cod, and Buzzards Bay, were chosen for coverage of the major lobstering regions of the state within resources available. For convenience, these regions are depicted as generalized hatchmarked areas wherein lobster gear sampled may be discontinuously distributed.

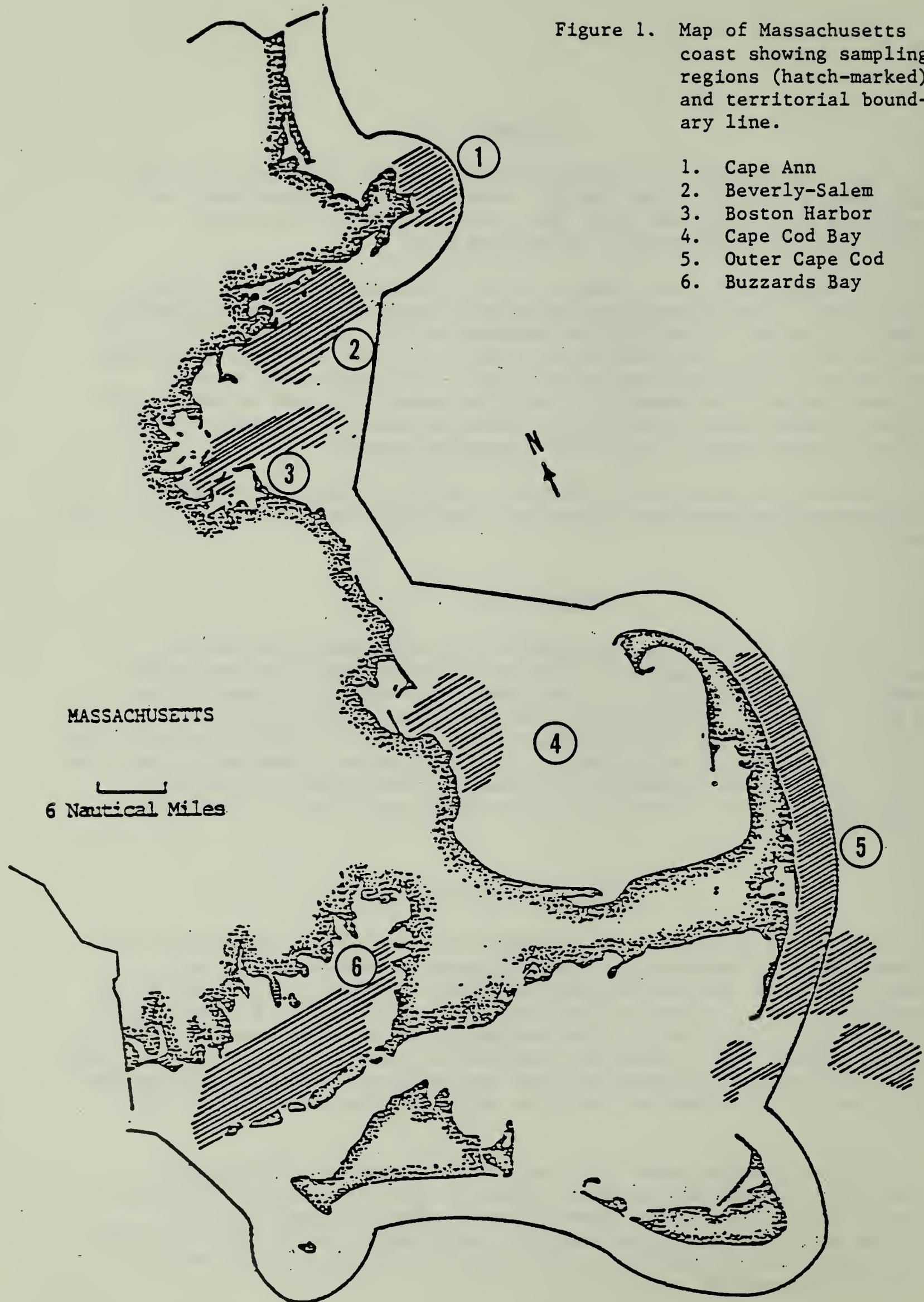
## SAMPLING PROCEDURE

Sampling of coastal waters was accomplished by monitoring catches during the normal lobstering operations of volunteer commercial lobstermen in each designated region. Multiple lobstering operations were observed to reduce bias from varying degrees of lobstering skill and to enhance areal coverage. Five lobstermen were monitored in the Gulf of Maine regions, two in the outer Cape Cod region, and two in Buzzards Bay. Pot-sampling trips were day trips, conducted a minimum of once per month region (except when man-power limitations precluded effort or cooperating lobstermen were not operating) during the major lobstering season, May-November.

Utilizing portable cassette tape recorders, sea samplers recorded carapace length (to the nearest mm and to the nearest 0.1 mm between 80.5 and 81.0 mm); sex; and condition, including the degree of shell hardness, culls and other shell damage, external gross pathology, mortality, and presence of extruded ova on females (ovigerous). Catch in number of lobster, number of trap hauls, set-over-days, trap and bait type were also recorded.

Figure 1. Map of Massachusetts coast showing sampling regions (hatch-marked) and territorial boundary line.

1. Cape Ann
2. Beverly-Salem
3. Boston Harbor
4. Cape Cod Bay
5. Outer Cape Cod
6. Buzzards Bay



## ANALYTICAL PROCEDURES

Data were computer coded and keypunched for analysis on the Woods Hole Oceanographic Institution's Digital Equipment Corporation VAX-11/780 computer system. A computer auditing process was used to uncover keypunch and recording errors and statistical analyses were performed with SPSS (Nie 1983) statistical subprograms.

The Kolmogorov-Smirnov two sample test and Mann-Whitney U/Wilcoxon W tests were used to determine the significance of year to year variation in parameters.

Because parameter means exhibit significant regional and monthly variation, an areal and temporal data weighting scheme was incorporated into analytical software. As a result, each month's data contribute equally to regional parameter means which are weighted by area in square nautical miles.

Unless specified otherwise, the terms "legal" or "legal sized" lobster include all lobster in the carapace length category  $\geq 81$  mm. The marketable segment of this category, which excludes ovigerous females, is analyzed separately and is referred to as "marketable lobster". The sublegal length category includes all lobster  $< 81$  mm.

Estimates of total instantaneous mortality ( $Z$ ) and total annual mortality ( $A=1-e^{-Z}$ ) were computed by two methods which produce extremes in the possible range of estimates. The method of Gulland (1969) requires computing the slope of the regression line of numbers at estimated age (15% molt groups, 14% for Buzzards Bay, were derived from tagging data) plotted in the natural log. Beverton and Holt's (1956) process employs Von Bertalanffy Growth Equation parameters and mean and minimum length of exploitable sizes.

Lobster landings data quoted is derived from lobstermen's catch reports which are compiled annually by the DMF Commercial Fisheries Statistics Project.

Since current management strategy stresses uniform coastwide regulations, all data are grouped for a coastwide analysis. However, the uniqueness of the Massachusetts coastline, its role in providing a temperature barrier which profoundly affects many marine species (Colton 1964), and the influence of offshore lobster stocks on the inshore resource mandate a regional data treatment as well.

## RESULTS AND DISCUSSION

During the period of May through November, 1987, eighty-nine sampling trips were made aboard commercial lobster vessels in Massachusetts coastal waters. A total of 39,022 lobster were sampled from 14,742 trap hauls.

The coastwide mean catch rate ( $CTH'_3$ , Estrella and McKiernan 1987), 0.737 marketable lobster per trap (standardized to 3 set-over-days), was 10% lower than the 1986 index, 0.816 (Appendix Table 1). Commercial landings from territorial waters also declined by 13%. A close correlation between the two seven-year data series is shown in Figure 2.

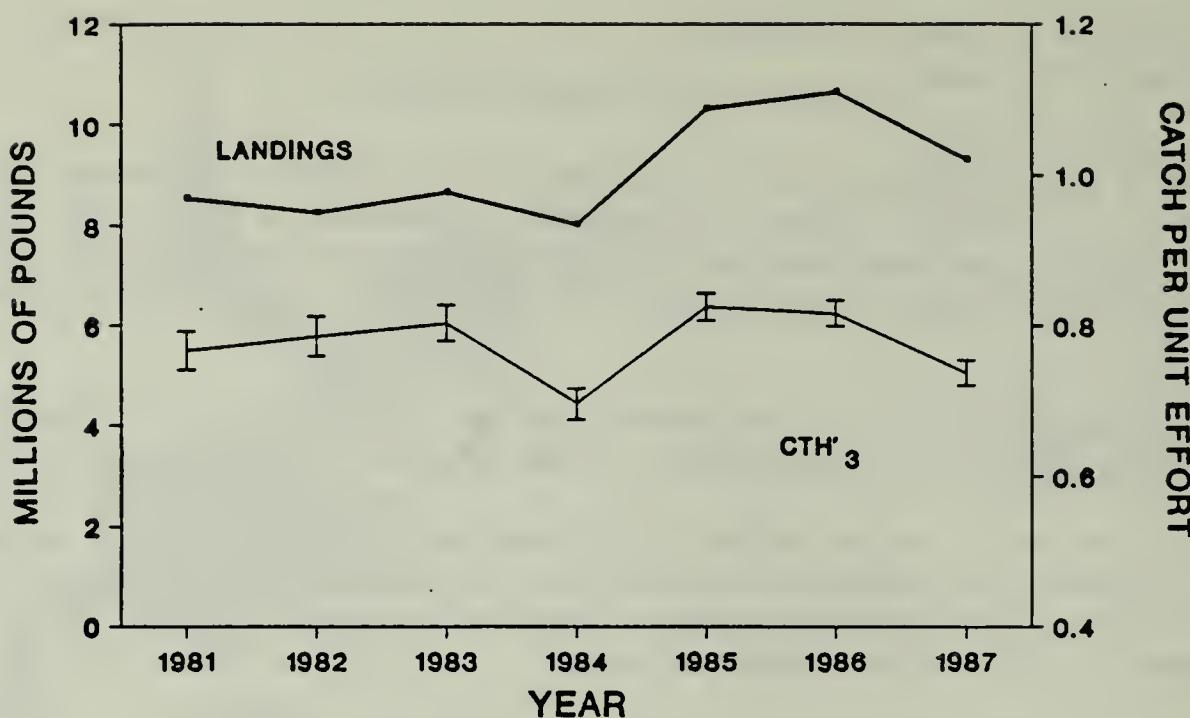


Figure 2. Catch per unit effort from coastal commercial lobster trap sampling and lobster landings for Massachusetts territorial waters, 1981-1987.

The catch rates of sublegal lobster also declined between 1986 and 1987 (Appendix Tables 2 and 3). Figure 3 presents a graphical analysis of 1986 and 1987 legal catch rate data by molt group. The 1986-1987 decline in catch rates is observable in all three molt groupings, and the dependency of the fishery upon the recruit molt group is clear.

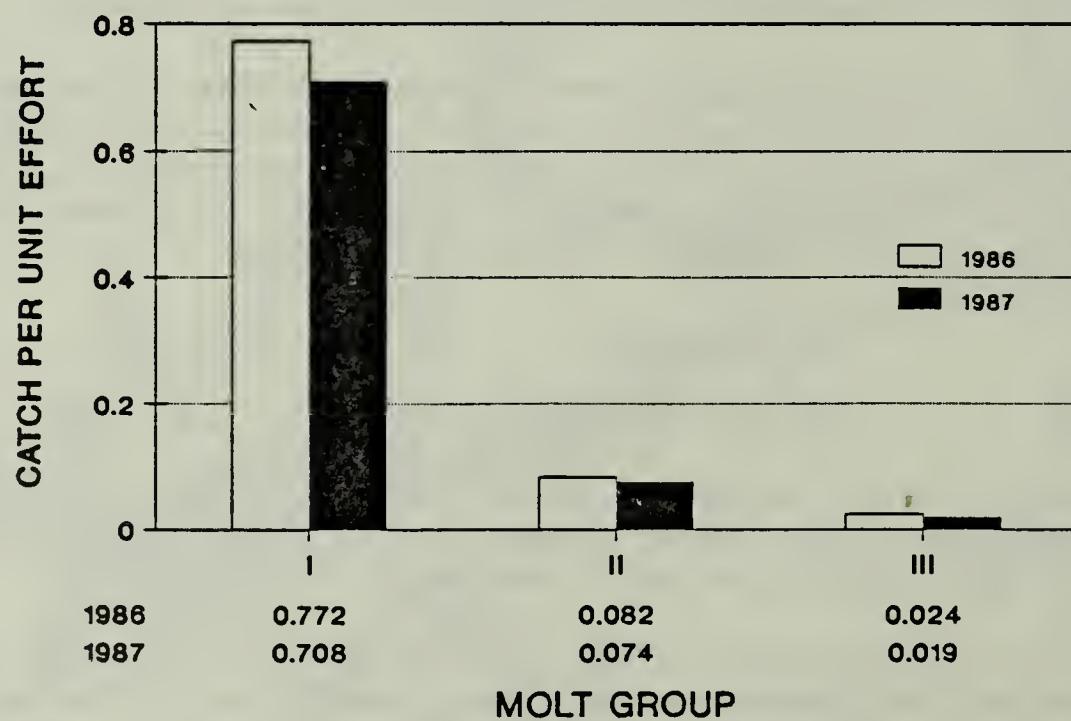


Figure 3. Catch rates of legal sized lobster by molt groupings, commercial lobster trap catch survey, Massachusetts coastal waters, 1986-1987.

This reduction in catch rates was probably caused by water temperature which was colder than normal during spring, 1987. The effect of cold water temperature in depressing the proportion of lobster molting is more apparent in a recruitment dependent fishery.

Of all females sampled during 1987, 9.2% were ovigerous compared to 9.1% in 1986 (Appendix Table 4). No significant difference was found between years ( $P = 0.942$ ). Trends in abundance of ovigerous females are depicted in Figure 4 (Appendix Tables 4-6).

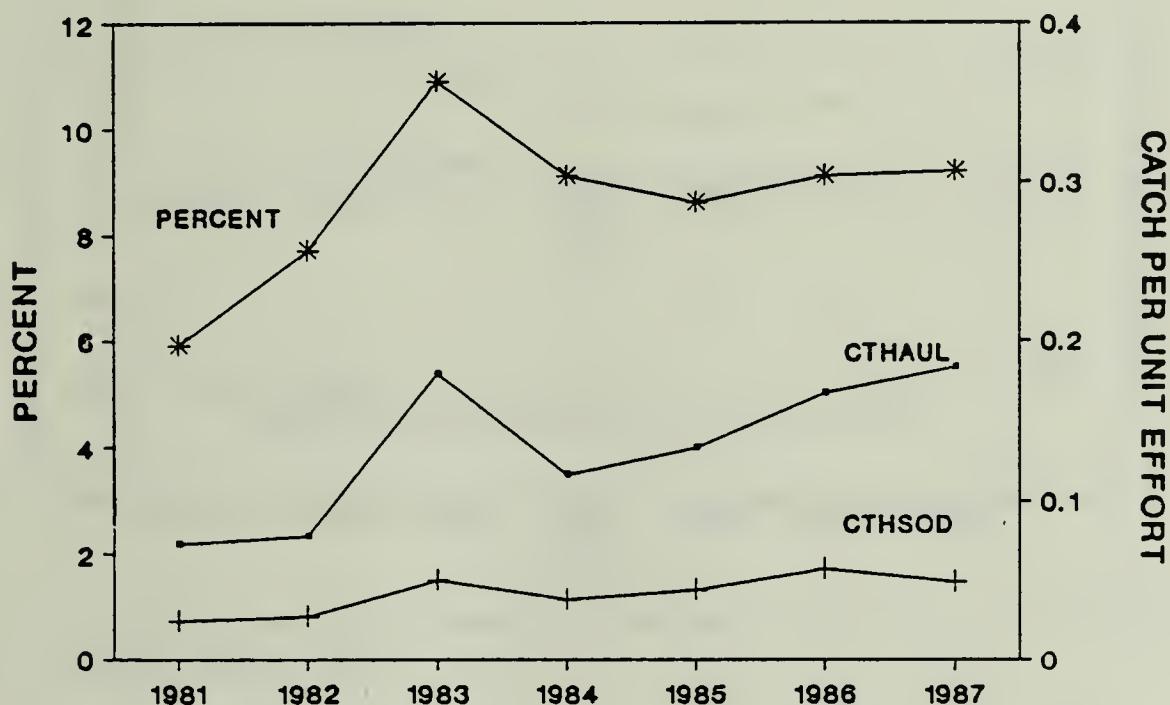


Figure 4. Relative abundance of ovigerous female lobster in percent of total females and catch per unit effort Massachusetts coastal waters, 1981-1987.

Exploitation rates were as high as 1986 indices (Appendix Table 7). Approximately 94% of the legal catch in our inshore regions (Cape Ann south through Cape Cod Bay and Buzzards Bay) was comprised of new recruits, i.e., lobster which recently molted into legal size. In contrast, this index was lower, 54%, for the primarily offshore migrant lobster east of Cape Cod.

Estimates of total mortality were also high. Indices for inshore Gulf of Maine regions ( $Z = 1.80-2.59$ ,  $A = 84\%-93\%$ ) and Buzzards Bay ( $Z = 2.36-3.48$ ,  $A = 91\%-97\%$ ) depict a fully exploited resource while those for the outer Cape Cod region ( $Z = 0.66-0.80$ ,  $A = 48\%-55\%$ ) indicated less fishing pressure was exerted on this lobster group (Appendix Table 8).

Rates of exploitation and mortality affect the size frequency of lobster. Their escalation generally depresses the mean size of the resource. Coastwide estimates (1981-1987) of exploitation and mortality (Gulland 1969 method used for example) were negatively correlated with mean carapace length of marketable lobster (Figure 5) which exhibited a slight downward trend in recent years (Appendix Table 7-9).

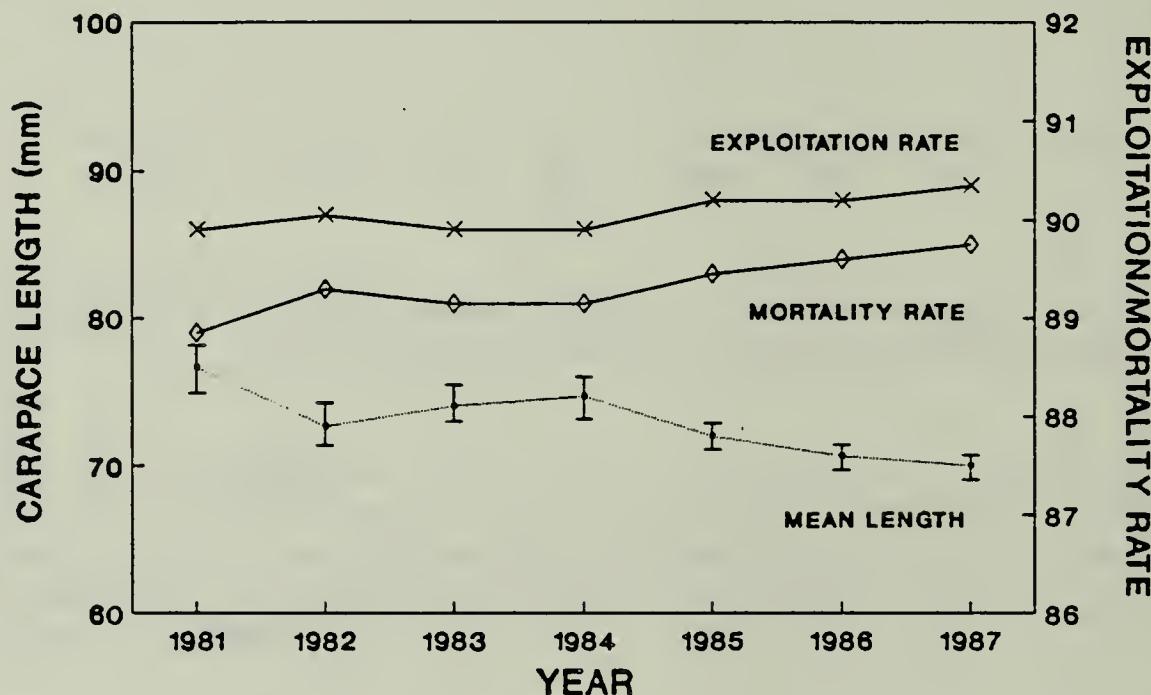


Figure 5. Relationship between exploitation and mortality rates and mean carapace length of lobster, Massachusetts coastal waters, 1981-1987.

Nevertheless, no significant difference was found between the coastwide mean carapace lengths of marketable lobster for 1986 (87.6 mm) and 1987 (87.5 mm,  $P = 0.509$ ). Sublegal sized lobster averaged 76.1 mm during both 1986 and 1987 (Appendix Table 10). However, the mean size of all ovigerous females declined from 88.1 mm in 1986 to 87.1 mm in 1987 ( $P < 0.001$ , Appendix Table 11).

The percentage of culls (lobster with one or both claws missing or regenerating) among all lobster sampled declined from 20.9% in 1986 to 17% in 1987 ( $P < 0.001$ , Figure 6, Appendix Table 12).

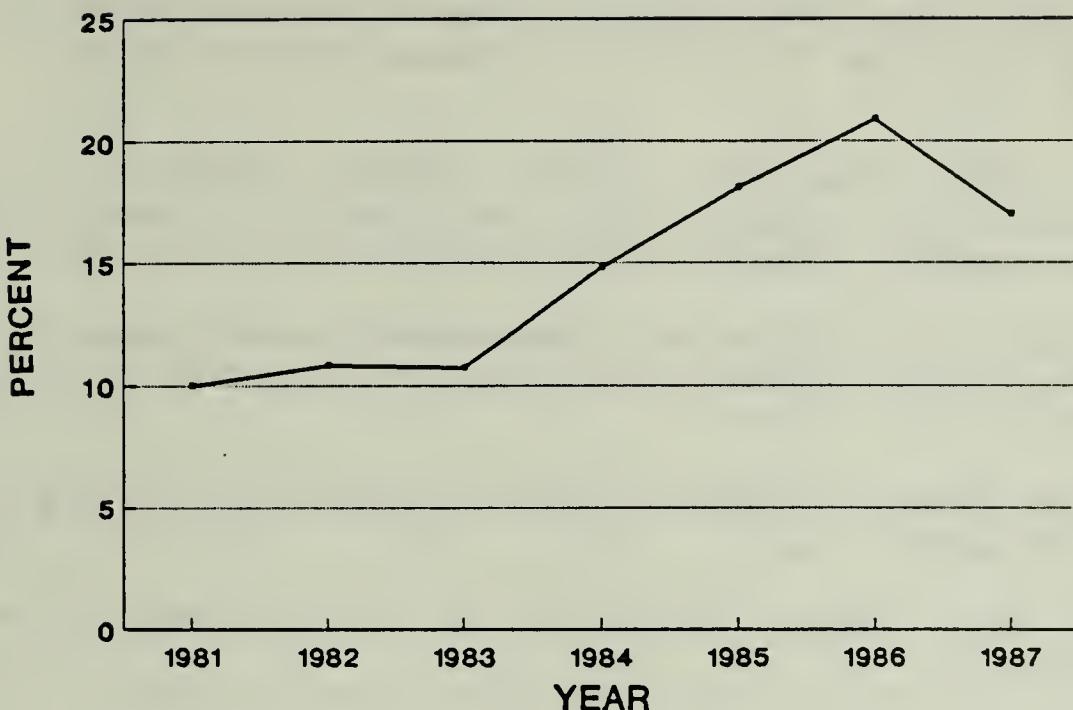


Figure 6. Percent of cull lobster in all commercial catches, Massachusetts coastal waters, 1981-1987.

The cull rates for legal and sublegal size groups similarly declined (Appendix Table 13-15).

The incidence of lobster found dead in traps was < 1%. This was consistent with 1986 data (Appendix Table 16).

#### ACKNOWLEDGEMENTS

We are indebted to the many commercial lobstermen who are involved in this cooperative lobster resource monitoring effort. The success of this program is due primarily to their continued interest and cooperation. Unfortunately, we must refrain from naming them in order to protect the confidentiality of their catch information. Gratitude is also extended to Brian Kelly and Vincent Malkoski of the Pilgrim Power Plant Project (funded by Boston Edison Company), Peter Hoar and Thomas Hoopes in data collection, James Fair who administered the project and reviewed the manuscript, Ann-Marie Schultz who supplied word processing assistance during the report drafting stage, and Kim Trotto who typed the manuscript. Automatic data processing, including data entry, was supported by the National Marine Fisheries Service (NMFS) Northeast Fisheries Center, Woods Hole, MA.

## LITERATURE CITED

Colton, J. B. 1964. History of oceanography in the offshore waters of the Gulf of Maine. U.S. Fish and Wildlife Service, Special Scientific Report, Fisheries No. 496, 1-18.

Beverton, R. J. H. and S. J. Holt. 1956. A review of methods for estimating mortality rates in exploited fish populations, with special reference to sources of bias in catch sampling. Reports et Proces-Verbaux des Reunions 140: 67- 83.

Estrella, B. T. and D. J. McKiernan. 1987. Massachusetts coastal commercial lobster trap sampling program, May-November, 1986. Massachusetts Division of Marine Fisheries, 65 p.

Gulland, J. A. 1969. Manual of methods of fish stock assessment. Manuals in Fisheries Science No. 4.

Nie, N.H. 1983. SPSS: statistical package for the social sciences, McGraw-Hill, New York.

APPENDIX

Table 1. CTH'3, by state and region, for all marketable lobster sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	0.767	0.785	0.803	0.696	0.825	0.816	0.737
Cape Ann	0.732	0.808	0.624	0.663	0.634	0.699	0.669
Beverly-Salem	0.934	0.898	0.881	0.835	0.663	0.496	0.611
Boston Harbor	--	--	--	1.108	1.254	1.096	1.058
Cape Cod Bay	0.710	0.776	0.680	0.479	0.716	0.822	0.533
Outer Cape Cod	0.808	0.824	0.765	0.598	0.856	0.811	0.937
Buzzards Bay	0.611	0.571	1.110	0.870	0.953	0.907	0.952

Table 2. CTHSOD, by state and region, for all American lobster < 81 mm, sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	0.580	0.672	0.718	0.521	0.647	0.700	0.578
Cape Ann	0.067	0.109	0.586	0.450	0.395	0.474	0.417
Beverly-Salem	0.708	0.711	1.263	0.948	0.833	0.801	0.863
Boston Harbor	--	--	--	0.901	1.162	1.138	1.156
Cape Cod Bay	0.710	1.013	0.639	0.322	0.594	0.551	0.371
Outer Cape Cod	0.037	0.024	0.383	0.033	0.035	0.027	0.088
Buzzards Bay	0.787	0.620	0.638	0.785	0.848	1.312	0.871

Table 3. CTHAUL, by state and region, for all American lobster < 81 mm, sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	1.473	1.401	1.624	1.389	1.705	1.899	1.873
Cape Ann	0.256	0.199	1.044	0.909	1.031	1.126	1.143
Beverly-Salem	1.855	1.713	2.526	2.504	2.567	2.435	3.482
Boston Harbor	--	--	--	2.773	3.038	3.314	3.334
Cape Cod Bay	1.544	1.680	1.345	0.825	1.337	1.512	1.031
Outer Cape Cod	0.233	0.145	0.210	0.189	0.160	0.161	0.324
Buzzards Bay	2.381	1.916	2.316	1.965	2.452	3.118	3.090

Table 4. Percent of females ovigerous, by state and region, for all American lobster sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	5.9	7.7	10.9	9.1	8.6	9.1	9.2
Cape Ann	1.7	3.1	4.4	3.2	4.6	5.0	4.5
Beverly-Salem	1.7	2.8	1.2	0.4	1.9	1.1	1.8
Boston Harbor	--	--	--	1.4	1.2	2.0	1.7
Cape Cod Bay	3.9	3.1	3.7	3.1	3.2	2.1	3.9
Outer Cape Cod	11.1	23.0	30.3	26.8	22.3	28.9	16.9
Buzzards Bay	16.0	16.9	32.5	26.6	25.0	25.3	31.0

Table 5. CTHSOD, by state and region, for all ovigerous female American lobster sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	0.024	0.027	0.050	0.038	0.044	0.057	0.049
Cape Ann	0.002	0.011	0.024	0.015	0.016	0.017	0.016
Beverly-Salem	0.011	0.009	0.008	0.003	0.011	0.004	0.010
Boston Harbor	--	--	--	0.009	0.007	0.015	0.012
Cape Cod Bay	0.020	0.025	0.016	0.009	0.015	0.010	0.012
Outer Cape Cod	0.012	0.028	0.040	0.030	0.038	0.032	0.034
Buzzards Bay	0.079	0.053	0.230	0.183	0.193	0.297	0.234

Table 6. CTHAUL, by state and region, for all ovigerous female American lobster sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	0.073	0.078	0.179	0.116	0.133	0.167	0.183
Cape Ann	0.010	0.016	0.038	0.027	0.039	0.047	0.048
Beverly-Salem	0.025	0.033	0.016	0.006	0.033	0.018	0.036
Boston Harbor	--	--	--	0.030	0.025	0.050	0.037
Cape Cod Bay	0.048	0.048	0.040	0.024	0.040	0.031	0.038
Outer Cape Cod	0.081	0.178	0.242	0.170	0.176	0.225	0.157
Buzzards Bay	0.243	0.139	0.828	0.515	0.555	0.748	0.889

Table 7. Estimated exploitation rates, by state and region, commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	86	87	86	86	88	88	89
Cape Ann	91	92	87	89	87	87	88
Beverly-Salem	89	92	94	88	96	96	97
Boston Harbor	--	--	--	93	94	96	96
Cape Cod Bay	90	93	92	94	93	94	92
Outer Cape Cod	46	43	42	38	48	46	54
Buzzards Bay	98	96	96	94	96	97	97



Table 8. Total instantaneous ( $Z$ )\* and total annual (A)\* mortality estimates of American lobster by region, Massachusetts coastal waters, 1981-1987.

	1981	1982	1983	1984	1985	1986	1987
	Beverton						
	Gilliland and Holt						
(1969) (1956)	(1969) (1956)	(1969) (1956)	(1969) (1956)	(1969) (1956)	(1969) (1956)	(1969) (1956)	(1969) (1956)
Cape Ann	1.65*	1.32	2.18	1.39	1.72	1.35	1.52
	81%**	73%	89%	75%	82%	74%	85%
Beverly-Salem	1.97	1.59	2.15	1.70	2.41	1.85	2.71
	86%	80%	88%	82%	91%	84%	93%
Boston Harbor							
Cape Cod Bay	2.53	1.64	2.69	1.92	2.42	1.72	2.52
	92%	81%	93%	85%	91%	82%	92%
Outer Cape Cod	0.43	0.54	0.46	0.55	0.42	0.53	0.33
	35%	42%	37%	42%	34%	41%	28%
Buzzards Bay	3.02	2.97	3.00	2.53	8.64	2.26	3.14
	95%	95%	95%	92%	99%	90%	96%
Regions combined	1.58	1.35	1.72	1.45	1.66	1.39	1.61
	79%	74%	82%	77%	81%	75%	81%

Table 9. Mean carapace length (mm), by state and region, for all marketable American lobster sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	88.5	87.9	88.1	88.2	87.8	87.6	87.5
Cape Ann	88.6	88.3	88.3	87.9	88.4	88.3	88.0
Beverly-Salem	87.6	87.0	86.6	86.9	86.2	86.2	85.8
Boston Harbor	--	--	--	86.8	86.9	86.4	86.6
Cape Cod Bay	87.2	86.4	86.9	86.1	86.4	86.3	86.7
Outer Cape Cod	98.2	97.5	97.4	99.7	97.0	96.3	94.6
Buzzards Bay	84.7	85.2	85.7	85.8	85.2	85.3	85.3

Table 10. Mean carapace length (mm), by state and region for all American lobster < 81 mm, sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	75.8	76.3	76.2	76.1	76.3	76.1	76.1
Cape Ann	78.0	77.7	77.5	77.3	77.6	77.1	75.9
Beverly-Salem	74.3	76.5	74.9	76.1	75.9	74.7	74.7
Boston Harbor	--	--	--	77.1	76.9	76.9	76.5
Cape Cod Bay	76.6	76.4	76.7	75.6	76.1	76.2	75.6
Outer Cape Cod	75.9	76.2	77.1	75.1	76.6	75.9	77.0
Buzzards Bay	75.8	75.5	76.8	76.4	76.1	76.0	76.6

Table 11. Mean carapace length (mm) of all ovigerous female American lobster, by state and region, sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	88.5	87.6	88.6	87.4	87.9	88.1	87.1
Cape Ann	109.0	100.3	94.3	90.5	93.8	95.0	91.6
Beverly-Salem	80.5	84.5	85.8	83.5	85.9	83.5	81.8
Boston Harbor	--	--	--	82.1	84.0	81.3	82.3
Cape Cod Bay	86.4	83.8	85.5	84.4	85.2	86.8	87.0
Outer Cape Cod	109.8	106.1	108.0	107.1	106.9	107.3	102.5
Buzzards Bay	78.1	79.6	81.6	83.0	80.1	79.4	80.2

Table 12. Cull rate (percent), by state and region, for all American lobster sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	10.0	10.8	10.7	14.8	18.1	20.9	17.0
Cape Ann	10.0	9.8	10.5	11.5	23.9	25.3	20.2
Beverly-Salem	8.3	8.6	10.2	20.9	23.0	30.0	24.1
Boston Harbor	--	--	--	13.3	19.3	19.1	16.9
Cape Cod Bay	11.1	10.7	10.9	15.6	18.3	21.6	16.2
Outer Cape Cod	5.7	11.3	8.9	13.0	13.4	16.1	12.6
Buzzards Bay	13.5	14.7	12.4	12.4	13.4	14.6	15.1

Table 13. Cull rate (percent), by state and region, for American lobster  $\geq$  81 mm, sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	8.1	9.7	9.2	12.7	14.8	17.0	14.7
Cape Ann	10.7	9.6	7.5	10.4	19.4	20.3	18.0
Beverly-Salem	4.3	7.7	7.4	15.5	19.3	22.1	17.1
Boston Harbor	--	--	--	10.1	16.2	15.8	12.9
Cape Cod Bay	9.3	9.3	10.0	13.2	14.5	18.1	15.0
Outer Cape Cod	5.3	10.3	8.1	13.3	12.5	14.9	13.1
Buzzards Bay	16.1	13.2	12.7	12.3	13.8	13.6	15.2

Table 14. Cull rate (percent), by state and region, for marketable American lobster sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	8.2	9.9	9.2	13.2	16.2	17.6	14.7
Cape Ann	10.8	9.8	7.3	10.5	20.9	20.7	18.4
Beverly-Salem	4.4	8.0	7.4	15.6	18.5	22.2	17.2
Boston Harbor	--	--	--	10.2	16.2	15.7	12.8
Cape Cod Bay	9.3	9.3	10.0	13.2	15.9	18.2	14.8
Outer Cape Cod	5.3	10.9	8.6	14.8	12.9	16.8	13.2
Buzzards Bay	16.9	13.1	12.3	12.6	15.4	14.1	15.4

Table 15. Cull rate (percent), by state and region, for American lobster < 81 mm, sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	11.2	11.5	11.6	16.1	20.2	23.2	18.2
Cape Ann	8.0	10.6	12.6	12.2	26.9	28.7	21.5
Beverly-Salem	10.0	9.0	11.2	22.3	24.0	31.8	25.3
Boston Harbor	--	--	--	14.5	20.5	20.0	18.0
Cape Cod Bay	11.9	11.3	11.4	17.0	20.2	23.4	16.8
Outer Cape Cod	7.8	17.9	13.5	11.7	18.6	22.8	11.0
Buzzards Bay	12.7	15.2	12.2	12.4	13.3	14.9	15.0

Table 16. Percent trap mortality by state and region for all American lobster sampled during commercial lobster trap catch survey, Massachusetts coastal waters, 1981-1987.

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
State	0.15	0.04	0.22	0.15	0.18	0.20	0.10
Cape Ann	0.00	0.00	0.09	0.27	0.03	0.16	0.00
Beverly-Salem	0.00	0.00	0.00	0.00	0.04	0.22	0.03
Boston Harbor	--	--	--	0.00	0.03	0.03	0.23
Cape Cod Bay	0.00	0.02	0.03	0.00	0.00	0.02	0.15
Outer Cape Cod	0.46	0.22	0.23	0.48	0.40	0.85	0.27
Buzzards Bay	0.62	0.00	1.13	0.43	0.76	0.25	0.01



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